FDTD analysis of nonlinear PBG waveguides for optical circuit applications

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Nonlinear PBG structures have attracted considerable attention as an optical material which is expected to play an important role in the future of the integrated optical circuits. In this study, a finite-difference time-domain (FDTD) method based on numerical simulation of oscillating dipole radiation [1] is used for Kerr-like nonlinear PBG waveguide analysis. In order to calculate dispersion characteristics of a PBG waveguide, the super-cell that includes an imperfect part of the periodic structure is used. A cubic equation is solved analytically within the main body of the FDTD algorithm to calculate the electric field intensity, which induces the nonlinearity [2].

A numerical tool based on the presented method can be used to analyze various components for integrated optical circuits. These components include PBG-based nonlinear directional couplers, all-optical switches, etc. Their functionality is explained through the analysis of dispersion characteristics and verified by conventional FDTD simulations. Some examples will be presented.

[1] I. S. Maksymov, L. F. Marsal and J. Pallarès, *Opt. Commun.*, (published on-line, 2005).
[2] I. S. Maksymov, L. F. Marsal and J. Pallarès, *Proceedings of the 12th International Workshop on Optical Waveguide Theory and Numerical Modeling,* Ghent, Belgium, 2004 (see also special issue OWTNM2004, to be published in Opt. Quant. Electron. in 2005).